COMMONWEALTH OF AUSTRALIA

BUREAU OF METEOROLOGY

Australian Rainfall Observer's Handbook

1954

Issued under the Direction of E. W. Timcke, Director of Meteorological Services, by Authority of the Minister of State for the Interior

By Authority
W. M. HOUSTON, Government Printer, Melbourne.

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PREFACE

In order that weather observations at different centres may be comparable, it is necessary that a uniform plan be adopted in equipping meteorological stations, in standardizing the methods of reading instruments, and in describing the various phenomena which it is desired to record. This is true not only for one particular country, but for the world as a whole, since weather processes are similar the world over.

Conferences of meteorologists from all countries have met from time to time to consider questions of observing and exchanging weather information, and the recommendations of the World Meteorological Organization form the basis of the instructions contained in these pages.

This handbook incorporates instructions previously issued to Australian observers in " Instructions to Country Observers ", 1907, and the " Australian Rainfall Observer's Handbook ", 1925.

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CONTENTS.

INTRODUCTION

WEATHER ELEMENTS AND THEIR MEASUREMENTS.

The weather at any particular time and place is the resultant of the condition of its various elements. These can be measured either directly with instruments, as in the case of temperature, rainfall or wind, or by estimation as, for example, visibility, amount of sky covered with cloud, &c.

Our personal comfort is in some considerable degree dependent on the condition of certain elements such as temperature and humidity (or the amount of water vapour in the atmosphere); other elements may not affect our senses yet they are important in other ways. The pressure of the air, for example, controls the movements of air whether in cyclones or gales which sweep a wide region or in a local sea breeze of a summer afternoon. All the elements vary from day to day and even from hour to hour, and the task of an observer is to describe them faithfully at stated times each day.

An observation consists of (1) the measurements of elements such as pressure, temperature, rainfall, &c., by means of instruments, (2) the estimation of values of elements for which no instruments are provided, (3) systematically and accurately describing the state of the weather according to specifications laid down by the World Meteorological Organization, and (4) carefully noting phenomena which occur irregularly, such as frosts, hail, thunderstorms or exceptional occurrences as, for example, very heavy rains, tornados and the like. The time of occurrence (beginning and ending) is of importance in the case of some phenomena such as fog, thunderstorms and heavy rain storms.

The elements observed and noted at Rainfall Observing Stations and the means by which they are measured or estimated are described in the following pages and are listed here as follows:—

Element.	How Observed.	Instructions on page
Rainfall	Rain Gauge	12
*Wind Direction	Wind Vane.	20
*Wind Speed	By estimation.	22
*Cloud Amount	Estimation.	24
*Cloud Height and Direction of Movement.	Estimation.	24–25
*Visibility	Estimation.	23
Phenomena	Note occurrence of Frost, Snow, Hail, Fog, Haze, Thunderstorms, Wind Storms, Dust Storms, &c.	
General State of the Weather	Note occurrence of showers, &c., appearance of the sky and character of the weather during the day.	28 Also see Manual No. 6 (Weather Code).

* Optional—see page 8.

The importance of regularity, care and precision in observations cannot be over-emphasized. An interested observer is always on the alert to record any exceptional happening and is keen to note any details which will be of value in determining the exact time and place an event occurs. This assists materially in studying the whole of the weather process of which the incident observed is a part. Regularity of observations at the specified time each day is of the greatest value in ensuring a continuity of records and the reliability of "mean" values of weather elements which are computed at the end of each week, month or year. (See pp. 14 and 34—Absence or changes of observers, &c.)

CLASSIFICATION OF WEATHER OBSERVING STATIONS.

Three orders of Weather Observing stations are defined:—

(1) **First Order Stations.**—At which continuous records or hourly readings are taken of pressure, temperature, wind, sunshine and rain, with eye observations at fixed hours of the amount, form and motion of cloud, visibility, and the general state of the weather, including the occurrence of hydrometeors.*

(2) **Second Order Stations.**—At which are recorded daily at two fixed hours at least, observations of pressure, temperature (dry and wet bulb), wind, cloud and weather with the daily maxima and minima of temperature, the daily rainfall and remarks on the weather, including the occurrence of hydrometeors.* At some stations, autographic records of one or more elements, viz., pressure, temperature, &c., are also obtained.

(3) **Supplementary Stations** at which observations are of the same kind as at second order stations but are (*a*) less complete, or (*b*) taken once a day only, or (*c*) taken at other than the recognized hours.

In Australia, **Rain Stations** are regarded as a special class of station at which are recorded the rainfall and, at the option of the observer, amount of cloud, visibility, wind (by estimation) and notes on the weather including hydrometeors.*

HOURS OF OBSERVATION.

For climatological purposes, the normal hours of observation are 0900 (9 a.m.) and 1500 hours (3 p.m.) Standard Time. Many third order stations and all rain stations read at 0900 hours only.

* Hydrometeors: Phenomena such as rain, fog, frost, thunderstorms, &c., which mainly depend upon modifications in the condition of water vapour in the atmosphere.

CONDITIONS OF EXPOSURE OF INSTRUMENTS.

RAIN GAUGE.

Exposure is a factor of primary importance in the case of the rain gauge, and care should be taken to place it well away from buildings and trees which may shelter it from precipitation. At the same time, it is necessary to avoid a situation which is too exposed. The gauge, if placed in the path of a strong wind, distorts the flow of air, and eddy currents may carry away rain drops and result in an inaccurate recording. The speed of the wind and eddies caused by friction increase rapidly with height above the ground, and if the gauge is placed unduly high, the wind may affect the recordings.

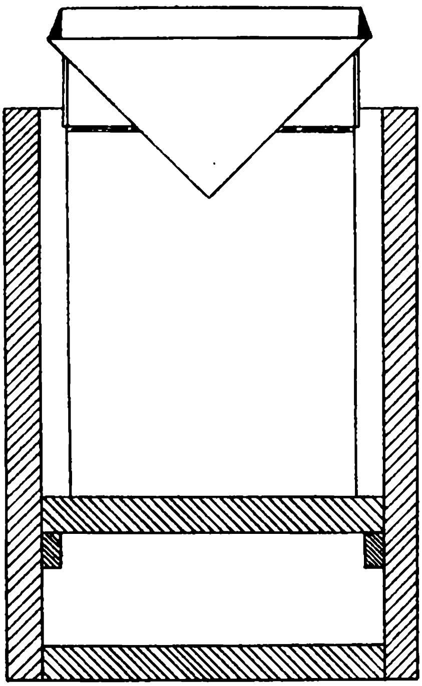

FIG 1.

In order that records at different stations may be comparable, it is necessary to adopt standard conditions of exposure.

The gauge should be placed on level ground in an open situation. It should be firmly fixed so that it will not blow over. This requirement may be met by setting it in a box sunk into the ground and provided with a shelf to raise the level of the rim above the edge of the box and 12 inches above the ground. It is important that the catchment surface of the gauge be horizontal. Care should be taken to see that the rim is level. It should not be replaced at an angle after a reading has been taken.

The distance of the gauge from all objects such as buildings, fences, growing trees or shrubs, &c., should be at least twice the height of such objects. It is an advantage, however, to have some shelter from prevailing winds in the form of a belt of trees or wall some distance away. At stations exposed to the wind as, for example, on the coast or on a hill top, it is also an advantage to select a slight hollow or even to build a low wall of turf about 12 inches in height at a distance of 5 feet around the gauge.

Situations to be avoided are a slope or terrace, a wall or roof or any place where the ground falls away steeply on the side of the prevailing wind. In many towns it is not practicable to obtain ideal conditions of exposure owing to the close proximity of buildings, fences, or trees. In a situation where it is unduly sheltered it may be an advantage to raise the gauge to 4 or 5 feet above the ground, but care should be taken in so doing to see that it is not unduly exposed to the wind. A gauge should not be placed on a fence unless it is entirely surrounded by buildings or trees at the specified distance.

The two main principles to be observed are—

(1) The gauge should not be unduly sheltered by trees, shrubs, or buildings.

(2) It should not be unduly exposed to high winds or placed in a situation subject to eddy currents (e.g., on a roof or wall).

Some forms of rain gauge and snow gauge are fitted with a "shield" to reduce loss due to the wind.

WIND VANE.

In selecting a site for a wind vane, the points to be observed are—

(1) That it is freely exposed to winds from all directions, and

(2) That it is not affected by local eddies which are formed about obstructions in the path of the wind. A vane on the ridge capping of a house or on a chimney may swing erratically in every strong wind.

An ideal exposure would be over level open ground at a distance from buildings and trees equal to at least ten times the height of such obstructions. The vane should be erected at a height of 33 feet above the ground. If placed over a building, a mast of at least two-thirds of this height should be erected above the building.

The primary consideration is that the direction indicated by the vane should be representative of the air stream flowing over the district near ground level.

EVAPORATION TANK.

It will be realized that the amount of evaporation from a moist surface depends largely on the nature of the surface. The rate of loss of water differs for differing evaporating surfaces, such as moist ground or the leaves of plants. For free water surfaces of less than 12 feet diameter it varies inversely as the area of the surface.

The form of evaporimeter in Australia is a cylindrical tank containing a volume of water of approximately 21 cubic feet with an evaporating surface of 7 square feet. The evaporation tank is 3 feet in diameter and is surrounded by a water jacket 6 inches in width which serves as a guard ring to prevent birds and small animals from crawling into and drinking water from the inner tank.

The whole is sunk into the ground to a depth of 3 feet so that the water surface is at ground level. Such a tank records the rate of evaporation which takes place under particular specified conditions.

The exposure of an evaporimeter should be such that it gives a true and representative measure of the rate of evaporation **from a tank of those specifications.** A comparison of records of evaporation in various parts of the country can be made only if the specified details of construction and conditions of exposure are strictly complied with.

Enclosing the water surface by a cover, or allowing trees or shrubs to grow over the evaporating surface, will have the effect of reducing the evaporation.

The rate of evaporation depends also on exposure to solar radiation. If the evaporation tank is shaded, a true record of evaporation will not be obtained.

The water surface should thus be freely exposed to the air and should not be sheltered by shrubs, trees or structures. It may be necessary to protect the tank from large birds in a dry climate, in which case a large mesh wire netting should be used.

The depth of the water surface below the rim is critical and the water surface should not be allowed to fall more than 3 or 4 inches below the rim.

Instructions as to the installation and maintenance of an Evaporation Tank and reading of the Hook or Float Gauge are to be found on pages 16—19.

THE OBSERVATIONS.

RAIN GAUGE AND MEASURE.

The rain gauge used in the Australian Meteorological Service is constructed of galvanized iron, with a bevelled brass rim of 8 inches diameter.* The gauge is in two sections, of which the upper part is in the form of a funnel which fits over a lower cylindrical can.

The total depth of the gauge is about 14 inches. It is placed in a box let into the ground in such a manner that the rim of the gauge is clear of the top edge of the box and stands 12 inches above the ground. (Fig. 1.)

Gauges of 5 inches (and on occasions, 6 inches) in diameter are on the market and confusion sometimes arises from observers purchasing and using a measure which does not correspond with the diameter of the gauge. *It is most important that the measure used be of the size appropriate to the diameter of the rim of the rain gauge. The use of any other measure will result in serious errors.*

A rough test of the accuracy of a measure in use may be made by measuring half-a-pint of water. The measurement will be approximately—

Using a measure for an 8-in. gauge	34 points.
Using a measure for a 6-in. gauge	61 points.
Using a measure for a 5-in. gauge	88 points.

In the event of the measure being of the incorrect size for the gauge in use a new measure of the correct size should be obtained immediately.

A rain gauge seriously damaged, found to be leaking, or having no proper rim or funnel should be repaired or replaced.

The capacity of a standard 8-in. gauge (container) is approximately 1½ gallons of water, or approximately 8 inches of rain.

Tropical Gauge.

A special type of gauge (8 inches) is provided for regions where very heavy rainfalls are experienced. This has a capacity of 5⅝ gallons approximately, or 30 inches of rain.

MEASURING RAINFALL.

The **Measuring Glass** is graduated in points from 0 to 50. The diameter of a measure used with an 8-in. gauge is approximately 2 inches but varies according to the scale magnification. A 5-in. measure is approximately 1 inch in diameter. The magnification of the scale engraved on the measuring glass is given by the ratio of the square of the diameter of the gauge to that of the glass.

It is an advantage to place a receptacle such as a glass jar in the gauge to collect precipitation. If the measure is left in the gauge in winter, it is subject to breakage by the freezing of the water contained therein on frosty mornings. The use of a jar or

*There are some official gauges issued many years ago of slightly different construction and material.

bottle facilitates pouring the water into the measure on windy mornings. It also conserves small amounts which may be lost by evaporation and prevents loss through possible leakage of the container. The measure should be kept under cover in a safe place when not in use.

Care of the Gauge.

The container should be tested for leaks at intervals, particularly if the gauge has been in use for some years. Loss of catch may result from leakage around the rim and along the seams as well as from the bottom of the container.

Any deformation by rough usage or accident should be guarded against and repaired immediately it occurs.

The rim should always be maintained in a level position. A tilted receiving surface may result in an incorrect recording.

Method of Making a Measurement.

The gauge should be inspected every day, as even in fine weather, especially in the winter months, some precipitation in the form of dew or fog may be collected.

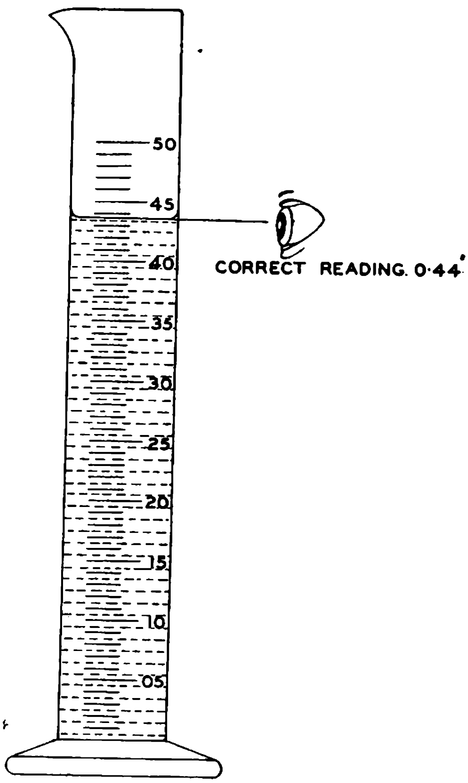

FIG. 2.

The reading should be made at a fixed time each day. The standard hour is 9 a.m. and this should be adhered to if at all possible. If any other hour is adopted, a note should be made on the entry sheet accordingly.

When reading the measure, it should be stood or held in an upright position so that the water surface will be in correct alignment with the scale.

The eye must be brought to the level of the water surface to avoid errors of parallax. (Fig. 2.) The reading should be taken at the bottom of the meniscus or curved surface of the water. (Water tends to creep up the glass at the edges.)

Each division on the measuring glass corresponds to 1 point. Frequently the water surface lies between two divisions, in which case the nearer of the two is taken. If, however, it lies midway between two divisions it is customary to take the one which is an odd number. Errors so introduced cancel out in the aggregate over a period of time. As a special case, amounts of between half a point and 1½ points are entered as 1 point. If there is less than half a point in the gauge, this is shown by the word "Trace", (abbreviation "Tr.").

If the water in the gauge exceeds 50 points, the measure is filled or nearly filled to its capacity and read and is then emptied into another receptacle and filled again. This is repeated, if necessary, until all the water has been measured. It is **important that the water be not thrown away** until a check reading has been made since errors are easily introduced. The amount of each successive measurement should be **written down** and then added (thus $47+47+49+24=167$). The total amount is then entered in the register.

All entries should be made to the day the gauge is read.

Heavy Rains.

For some purposes it is important to know the amount of rain which falls in short periods (i.e., minutes or a few hours). Although self-recording gauges afford the fullest information, much useful data can frequently be obtained from an ordinary gauge by noting the times a storm begins and ends and noting the amount of rain recorded in the interval. Thunderstorm rains are frequently very heavy and are a serious factor in soil erosion as well as in drainage problems.

When such special readings are made, the water should be returned to the gauge so that it will be included in the next measurement at the normal hour of observation. On some rare occasions, the amount of rain in 24 hours may be so heavy that the gauge will overflow. Should there be any danger of this happening, the amount that has fallen should be measured at some intermediate hour and not returned to the gauge. Care should be taken to see that **this reading is added to the amount in the gauge at the end of the 24-hour period (i.e., at 9 a.m.).** In such circumstances, the gauge may be emptied into another receptacle and the measurement made under shelter.

Absence of Observer.

An assistant should, if practicable, be trained to measure the rainfall in the absence of the usual observer. It is important that the continuity of the records be maintained.

Breakage of Measure.

In the event of a breakage of the rain-measure a replacement should immediately be requested from the Weather Bureau of the State Capital City. Any rain which is collected in the meantime should be bottled, labelled with the date, and measured when the new measure is received.

MEASUREMENT OF SNOW.

On days of snowfall when **water collected** in the gauge has frozen, the observer has three alternatives—

(1) If snow is not falling at the hour of observation, the gauge (funnel and receiver) may be brought indoors and its contents melted and measured in the ordinary way. Care should be taken not to apply fierce heat and melt the solder along the seams. If excessive heat is applied there may also be some loss due to evaporation. In any case, a flat plate should be placed over the top of the gauge to prevent escape of water vapour. The gauge may be stood in a basin of hot water until all the snow has melted.

(2) A cloth dipped in hot water may be applied to the outside of the funnel or receiver, or both, to melt the snow or ice. The water is then measured in the usual way. Precautions should be taken against allowing any hot water to drip into the gauge.

(3) A definite amount of warm water may be temporarily measured into the measuring glass (taking care not to break the glass) and then poured into the gauge. The amount of water added in this way must be subtracted from the total amount measured. Only sufficient warm water to melt the snow or ice should be used.

If snow is falling at the hour of observation, either method (3) or (2) should be adopted.

On days when all the precipitation has occurred in the solid form a check reading may be obtained by inverting the funnel of the gauge over a place where there has been no drift and where the depth is representative of the average over a level surface. The cylinder of snow thus cut out is melted and measured in the usual way.

Care should be taken to measure only snow which has fallen in the preceding 24 hours. At mountain stations **a wooden or stone floor may be constructed** for the purpose of measuring snow fall. A generally level site should be selected.

As a rough approximation, 1 foot of freshly fallen snow may be taken as equivalent to 1 inch of rain.

The depth of snow is determined by plunging a scale vertically into the snow where it lies evenly.

At mountain stations, particularly in South-eastern Australia, it occasionally happens that the rain gauge is entirely buried in snow or, on the other hand, snow is blown out of the funnel by wind eddies.

The observer should, on each morning during periods of heavy snowfall, make three separate measurements—

(1) the amount of water (actual rain and thawed snow) in the gauge;

(2) the amount of unmelted snow converted into water as explained above, including any snow immediately above the funnel (which should be separated (i.e., cut out) and pressed down into the funnel).

(3) the depth of fresh undrifted snow lying on a level surface.

The sum of (1) and (2) gives the amount of precipitation for entry in the register. (3) should be determined by taking the average of several measurements in different parts of the level surface. The resulting measurement of depth of snow should be entered in the remarks column.

If a pluviometer is used at a mountain station, it is advisable in periods of heavy snowfall to burn a nightlight in the gauge so that the snow is melted as it falls.

SNOW GAUGE.

A special gauge for the measurement of snow may be used instead of the rain gauge. This consists of a cylinder 4 feet in depth, having a brass rim of 8 inches diameter but no funnel. Snow which is collected is melted and measured in the manner described above under " Measurement of snow."

The snow gauge need only be set up and used in the winter months, and care should be taken to see that water does not collect in it when it is not actually in use.

In a windy site the snow gauge should be fitted with a " Nipher " or similar form of shield to prevent loss of record through eddy currents.

EVAPORIMETER—Description (See also p. 10).

The evaporimeter in use in Australia (Fig. 3.) consists of two cylindrical tanks, one inside the other, let into the ground. The inner tank, which is 3 feet in diameter, stands 2 inches higher than the outer one which is 4 feet in diameter. The water from which the evaporation measurements are taken is contained in the inner tank and the level of the water is accurately determined by means of a **hook (or float) gauge.** From the difference in two readings, usually at intervals of 24 hours, the amount of evaporation is calculated.

Installation of Evaporation Tank.

The outer tank is sunk flush with the ground, and must rest on a smooth, well packed, level bottom. Projecting stones are liable gradually to produce leaks. Both tanks should be tested for leaks before being put into position, especially the inner one. The inner tank rests on the floor of the outer and is concentric with it. Both tanks should be filled with water at the same time, to the levels stated below. The outer tank acts as a guard ring to the inner one, producing approximately uniform temperature conditions over its surface. It also prevents birds and small animals from entering or drinking from the inner tank.

Installation, Care, and Maintenance of the Hook Gauge.

The Hook Gauge is attached to the tank by means of two 2 B.A. bolts and nuts, with spacing washers, which are bolted through the two holes in the side of the inner tank. Place the spacing washers over the bolts between the tank and the lug extending down from the Hook Gauge.

The set screws bearing on the lug and side of the tank are for adjusting the vertical alignment of the gauge. These should be adjusted until the gauge, and its reflection in the still water are in one straight line when viewed from two positions at right angles.

The Hook Gauge should be checked regularly to ensure that it is always accurately vertical when readings are taken. The set screws should be kept tight so that the gauge is rigid on the rim of the tank. The rack and gear should be kept lightly greased.

Setting and Reading the Hook Gauge.

When measuring the level of water in the tank, adjust the Hook Gauge by means of the thumb screw until the point of the hook just touches the surface of the water from below. By observing the water surface where it is broken by the point of the hook so that a reflection of a smooth line (such as the edge of the tank) becomes distorted when the surface is just broken by the point of the hook, consistent readings are easily obtainable.

The scale is in inches and tenths, and the vernier gives hundredths in the usual manner. With reasonable care an accuracy of $\pm$ 0·005″, is obtainable.

Care and Maintenance of Tank

The outer tank should be kept completely filled with water, and the inner tank should be filled to within 3 to 4 inches of the rim. If rainfall exceeds evaporation, water should occasionally be removed from the tank, or, if the evaporation exceeds the rainfall, water should be added, so that the level of the water in the inner tank is maintained at about 3 to 4 inches from the top. The upper and lower extremes of water level which can be measured by the Hook Gauge are approximately 1 inch and 6 inches below the rim of the inner tank, but every effort should be made to keep the water level between 3 and 4 inches from the rim to ensure uniformity of exposure at all stations and at all times.

The level of the water should be read by means of the Hook Gauge before and after water is either removed or added, and due allowance should be made when the daily evaporation is calculated.

The tank should be emptied and cleaned out whenever necessary. Consistent records can be kept only if the water surface is clean and the water reasonably pure. The presence of dissolved materials in the water retards evaporation and may speed corrosion of the tank and fittings.

Calculation of the Amount of Evaporation.

The Hook Gauge is set and read each day at 9 a.m. Several settings should be made and a mean of the readings taken as the correct level of the water in the tank. When no rain has fallen, and no water has been added to or taken from the tank, the amount of evaporation during the 24 hours is simply the difference in the readings of the Hook Gauge.

Example 1.

To-day's reading ..	3·65″	
Yesterday's reading	3·41″	(subtract)
Amount of Evaporation ..	0·24″	

When rain has fallen during the 24 hours concerned, due allowance must be made, as follows:—

Example 2.

To-day's reading	3·35″	
Add Rainfall (16 points) ..	0·16″	
	3·51″	
Yesterday's reading	3·41″	(subtract)
Amount of Evaporation ..	0·10″	

When it is necessary to adjust the water level in the tank (as described in the previous section) readings **before** and **after** the change should be made and entered in the field book, with explanatory notes. The change in the water level should be made directly after the 9 a.m. observations.

Example 3.

Yesterday's reading ..	2·12″	
Water removed after yesterday's 9 a.m. observation. Reading after water removed	3·27″	
To-day's reading	3·78″	
Add Rainfall (10 points)	0·10″	
	3·88″	
Yesterday's reading	3·27″	(subtract)
Amount of Evaporation	0·61″	

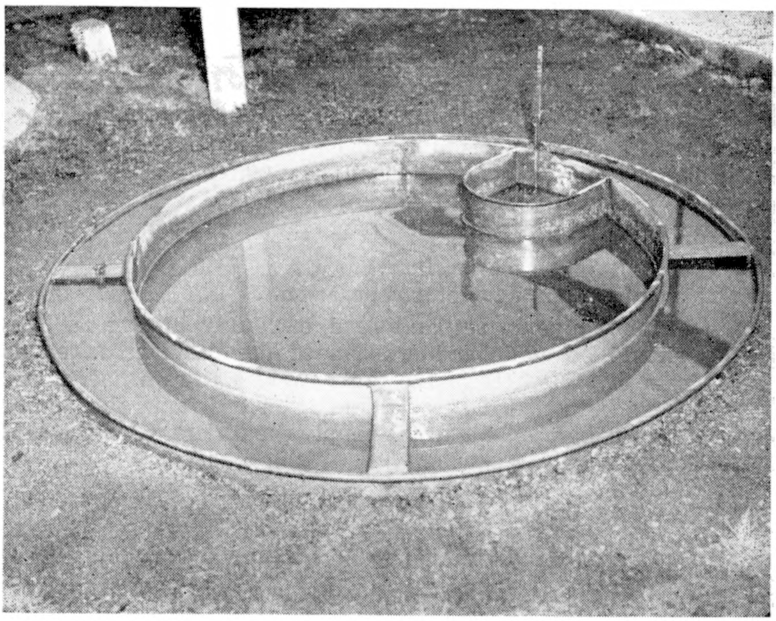

FIG. 3.

Float Gauge.

In many evaporation tanks in use the reading is made by means of a micrometer fixed to an upright standard bolted to the side of the inner tank. The level of the water surface is obtained by screwing up or down a circular disc so that it just touches the upper end of a rod which is attached to a glass float partly immersed in the tank. The circumference of the circular disc is graduated into 100 divisions. It is carried on a screw thread of such a pitch that one rotation corresponds to one division of a fixed vertical scale attached to the upright standard. The latter is graduated in inches and tenths. One division of the circular scale is thus equal to one thousandth of an inch.

To read the evaporimeter the circular disc is rotated until its lower surface is just touching the top of the float rod. The reading in inches and tenths (to the nearest tenth above the zero mark on the arm of the movable scale) is taken from the fixed scale. The hundredths (or thousandths) figure is then taken from the horizontal rotating scale opposite the pointer on the edge adjacent to the fixed scale. The procedure in measuring the evaporation by subtracting one reading from another made after an interval of 24 hours and allowing for rainfall is as described for the hook gauge.

WIND.

Wind is completely specified when we know its direction and speed. Its character, as regards steadiness or gustiness, should also be noted.

ISOGONIC CHART

FROM DATA COMPILED BY PROPERTY AND SURVEY BRANCH — JUNE 1942

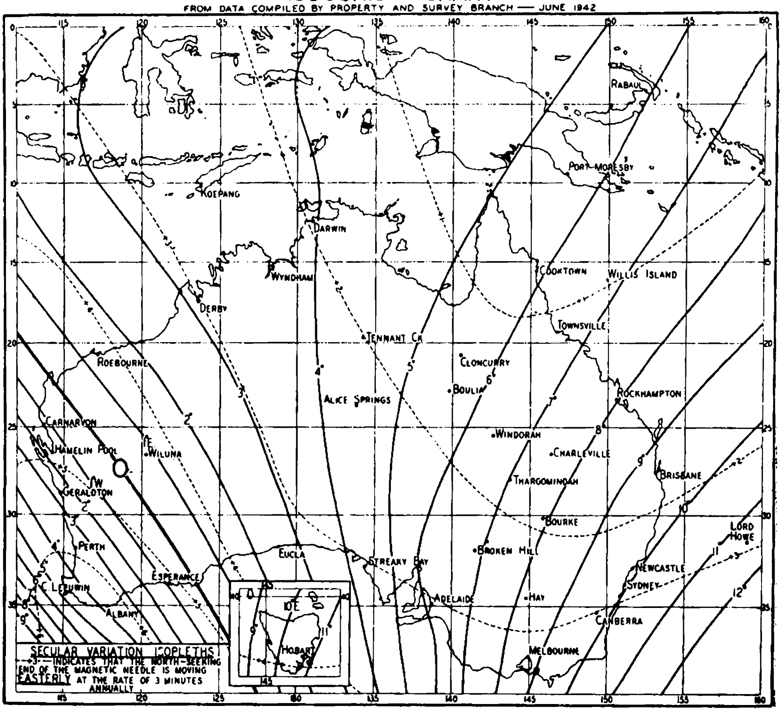

FIG. 4.

The Specification of Direction.

Directions are specified in two main ways, first by the name of the point of the compass nearest to the direction required, second by stating the number of degrees from north round by east through the whole 360°. Thus east = 90°, south = 180°, west = 270° and north = 360°.

The points of the compass (16 points) are shown in Fig. 5. Without special means it is not usually possible to estimate the direction of wind or cloud movement nearer than to one of these 16 points.

The convention adopted in recording wind direction is to state the direction from which it is blowing. All directions should be "true" and not "magnetic", and estimated to the nearest of the following 16 points:—

N	North	S	South
NNE	North-north-east	SSW	South-south-west
NE	North-east	SW	South-west
ENE	East-north-east	WSW	West-south-west
E	East	W	West
ESE	East-south-east	WNW	West-north-west
SE	South-east	NW	North-west
SSE	South-south-east	NNW	North-north-west

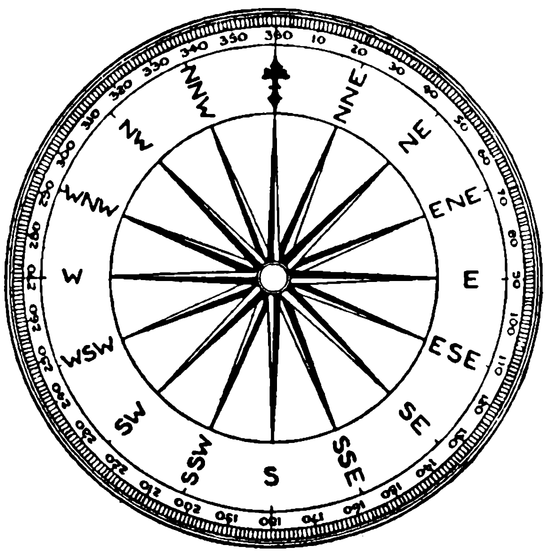

FIG. 5.

The direction required is that of the general current in the neighbourhood, and care must be taken to avoid being deceived by eddies due to buildings, trees, &c., or by the effects of the direction of streets. A well-exposed and sensitive wind vane is the best indication as to the direction of the wind, but nearby smoke or the set of flags also give useful indications. Observations of distant smoke or flags, &c., are, however, most unreliable, and should not be used.

If a wind vane be used, care must be taken—

(1) That it is freely exposed on all sides.

(2) That it moves freely. Before the wind vane direction is accepted, it should be noted that the vane is responding to the fluctuations in wind direction. If the wind is not sufficiently strong to move it, other means of ascertaining the direction must be used.

(3) That the cardinal points on the vane are correctly set and that the vane is well balanced; i.e., that it has no bias to set itself in a particular direction.

Wind Vane.

The Wind Vane used by the Meteorological Service in Australia, is illustrated in Fig. 6. The vane is specially constructed so as to be well balanced when resting on its pivot point. The design of the vane ensures a large turning moment about the axis so that it is sensitive in light winds.

In strong winds a sensitive vane tends to oscillate considerably but the mean direction from which the wind is blowing can be determined by estimating the mean position about which the vane swings.

The vane is packed in separate parts, the assembly of which is self-explantory. The spindle on which the vane rotates is connected to a short length of 1½-in. piping and a flange plate which can be bolted to the top of a wooden post, or in a suitable position on a structure. The arms carrying the pointers, N.S.E.W., are screwed into a centre piece which can be clamped in the correct position on the spindle. The positions of the pointers should frequently be examined and tested as the wooden post or mast may warp and twist, or damage may be caused to the arms or vane by strong winds.

Instructions regarding the proper exposure of a wind vane are found on page 10.

In setting up a wind vane the " North " pointer should be set to " true " North—not to " magnetic " North. The amount by which the compass differs from true North can be found by reference to the map in Fig. 4. For example—at Melbourne the compass reading is approximately 9 degrees east of true North; at Perth, 3½ degrees west of true North.

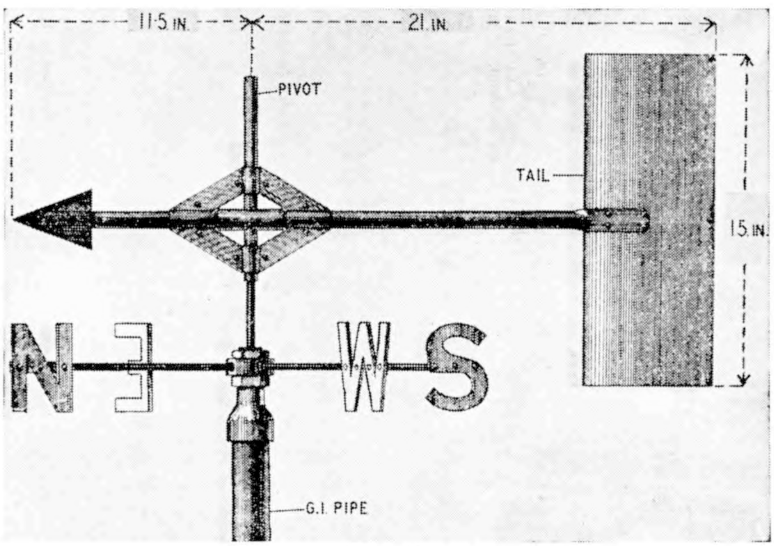

Fig. 6.

Wind Speed.

The speed of the wind is specified, according to the following table:—

SPECIFICATION OF THE BEAUFORT SCALE WITH PROBABLE EQUIVALENTS OF THE NUMBERS OF THE SCALE.

Beaufort No.	Equivalent Speed in Knots.	Explanatory Titles.	Specification for Coast Use.	Specification of Beaufort Scale for Use on Land, based on Observations made at Land Stations.	†Mean Pressure (at Standard Density) on a Disc of 1 sq. ft.		Limits of Speed. At 10 m. (33 feet) in the open.		
					mb.‡	Lb. per sq. ft.	Miles per hour.	Metres per second.	Feet per second.
0	0	Calm ..	Calm	Calm; smoke rises vertically ..	0	0	Less than 1	Less than 0·3	Less than 2
1	1–3	Light air ..	Fishing smack* just has steerage way	Direction of wind shown by smoke drift, but not by wind vanes	·01	·01	1–3	0·3–1·5	2–5
2	4–6	Slight breeze ..	Wind fills the sails of smacks, which then travel about 1–2 miles per hour	Wind felt on face; leaves rustle; ordinary vane moved by wind	·04	·08	4–7	1·6–3·3	6–11
3	7–10	Gentle breeze ..	Smacks begin to careen, and travel about 3–4 miles per hour	Leaves and small twigs in constant motion, wind extends light flag	·13	·28	8–12	3·4–5·4	12–18
4	11–16	Moderate breeze	Good working breeze; smacks carry all canvas, with good list	Raises dust and loose paper; small branches are moved	·32	·67	13–18	5·5–7·9	19–27
5	17–21	Fresh breeze ..	Smacks shorten sail	Small trees in leaf begin to sway; crested wavelets form on inland waters	·62	1·31	19–24	8·0–10·7	28–36
6	22–27	Strong breeze ..	Smacks have double reef in mainsail; care required when fishing	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty	1·1	2·3	25–31	10·8–13·8	37–46
7	28–33	High wind ..	Smacks remain in harbour, and those at sea lie to	Whole trees in motion; inconvenience felt when walking against wind	1·7	3·6	32–38	13·9–17·1	47–56
8	34–40	Gale	All smacks make for harbour, if near	Breaks twigs off trees; generally impedes progress	2·6	5·4	39–46	17·2–20·7	57–68
9	41–47	Strong gale ..	.. ..	Slight structural damage occurs (chimney pots and slates removed)	3·7	7·7	47–54	20·8–24·4	69–80
10	48–55	Whole gale ..	.. ..	Seldom experienced inland; trees uprooted; considerable structural damage occurs	5·0	10·5	55–63	24·5–28·4	81–93
11	56–63	Storm	.. ..	Very rarely experienced; accompanied by widespread damage	6·7	14·0	64–71	28·5–32·6	94–105
12	Above 63	Hurricane ..	.. ..	.. ..	8·1	Above 17·0	Above 71	32·7 or above	Above 105

* The fishing smack in this Table may be taken as representing a trawler of average type and trim. For larger or smaller boats and for special circumstances allowance must be made.

† The pressure due to the wind on any object exposed to it arises from the impact of the air on the windward side and suction on the leeward side; the mean pressure depends on the shape and size of the object. The values given are for a disc of 1 square foot in area, but they apply with fair approximation for circular or square plates from 1 sq. foot to 100 sq. feet in area.

‡ One millibar = 1,000 dynes per square centimetre—approximately 10 kilogrammes per square metre.

VISIBILITY.

The importance of visibility observations has increased in recent years with the development of aviation and the demands of navigators for exact specifications of the degree of transparency of the atmosphere. The most direct method of specifying visibility is to give the extreme distance at which objects are visible to an observer under normal conditions of illumination.*

In practice objects are selected at fixed distances as specified in Manual No. 6 (Weather Code).

For distances up to 3 miles, trees, houses, church spires, &c. are suitable objects, but for greater distances larger objects are recommended, such as the natural features of the landscape—hills, mountain peaks, &c. which stand out against the skyline.

In general, objects should be chosen which may be viewed against the horizon sky. They should be dark in color, and as far as possible subtend an angle of more than ½ degree in the horizontal and vertical directions, but not more than 5 degrees.

As it is not always possible to find objects at the exact distance specified, a variation of 10 per cent. from the chosen distance is allowed.

Difficulties may arise in connexion with the choice of objects when the visibility at the station varies in different directions owing to permanent local conditions, as for example, where a station lies on one side of a smoky area. In such a case, if there is a choice of objects at a given standard distance, the one likely to be most clearly seen should be adopted. Accuracy of distance, however, should not be sacrificed for this purpose.

An observer undertaking visibility observations should have good eyesight so that he can identify objects at a distance of 6 or 10 miles on a clear day with good daylight illumination without the aid of field glasses or a telescope. These should never be used for visibility observations.

For recording the density of fog, it is useful to state the maximum distance in yards that objects are visible.

Observations of visibility at night present difficulties which vary according to locality. A scale for night observations based on distances from lights of 100 candle power has been adopted provisionally and special instructions are issued as required.

CLOUDS.

Cloud observations include—

(1) Amount of sky covered;

(2) Direction and speed of cloud movement;

(3) Cloud forms and their classification.

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*It is important to note that visibility does not decrease to zero as night falls, in ordinary circumstances.

Amount of Cloud.

The amount of cloud is expressed in eighths (oktas) of sky covered: thus 8 represents a completely overcast sky and 0 a cloudless sky, while figures 1 to 7 are used to signify the number of eighths of cloud cover when the sky is neither clear nor overcast.

In estimating the amount of cloud of a specified form or type, such as low cloud, the area occupied by every other form or type visible at the time should be regarded as if it were blue sky.

On occasions when fog is present and is so thick as to make it impossible to tell whether there is cloud above it, the cloud amount should be recorded as 8, the fog being regarded as cloud at ground level. If the sky is visible the cloud amount above the fog layer should be estimated. If the sun or stars can be seen through the fog and there is no evidence of cloud above the fog the cloud amount should be entered as 0. In all cases where visibility is affected and the sky partly or completely obscured, the cause of the obscurity should be mentioned in the remarks on the weather.

Direction of Motion and Speed.

The direction of motion of clouds is always stated as the direction from which the cloud is coming.

To avoid errors due to perspective a point of a cloud should be selected which is rising from or descending towards the horizon nearly vertically i.e. moving directly towards or away from the observer.

The observer should place himself in such a position that the point of cloud is in line with his eye and some fixed object such as the top of a flagstaff, gable of a house or angle of a branch of a **dead** tree. The head should be fixed against some support otherwise the apparent motion of the cloud may be due in part to the movement of the head of the observer. By watching the direction of movement away from the fixed object and projecting the line of observed movement to the horizon, the direction of movement of the cloud can be determined. The direction of true North must, of course, be determined beforehand.

Observations of **Cirrus** cloud are of particular importance as they give valuable information as to the movement of air streams at heights of some 4 to 8 miles above the ground.

When observing such clouds it is advisable to protect the eyes from glare by wearing dark glasses.

It is important to record the date, hour, direction of movement, and if possible the speed of movement. A little experience will enable the observer to give a qualitative statement of the apparent speed of clouds by means of such designations as **slow, moderate, fast,** &c.

For the accurate determination of the direction of movement of clouds, some form of nephoscope should be used. These instruments can also be used to determine the angular velocity of clouds.

Cloud Forms and Their Classification.

The international classification of cloud forms is based upon four fundamental types—Cirrus (thread type), Cumulus (heap type), Stratus (flat or sheet type) and Nimbus (rain cloud).

Four families of clouds are recognized—

A. High Clouds—mean lower level 6,000 metres=20,000 feet. Cirrus, Cirrocumulus, Cirrostratus.

B. Middle Clouds—mean upper level 6,000 metres=20,000 feet, mean lower level 2,600 metres=8,500 feet. Altocumulus, Altostratus.

C. Low Clouds—mean upper level 2,600 metres=8,500 feet, mean lower level close to the ground. Stratocumulus, Stratus, Nimbostratus.*

D. Clouds with vertical development—mean upper level that of Cirrus, mean lower level 500 metres=1,600 feet. Cumulus, Cumulonimbus.

Definitions and Descriptions of the Forms of Clouds.

1. CIRRUS (Ci.).—**Detached clouds of delicate and fibrous appearance, without shading, generally white in colour, often a silky appearance.**

Cirrus appears in **the most varied forms,** such as isolated tufts, lines drawn across a blue sky, branching feather-like plumes, curved lines ending in tufts, &c.; they are often arranged in bands which cross the sky like meridan lines, and which, owing to the effect of perspective, converge to a point on the horizon, or to two opposite points. (Cirrostratus and cirrocumulus often take part in the formation of these bands.)

2. CIRROCUMULUS (Cc.).—**A cirroform layer or patch composed of small white flakes or of very small globular masses, without shadows, which are arranged in groups or lines, or more often in ripples resembling those of the sand on the sea shore.**

In general, cirrocumulus represents a degraded state of cirrus and cirrostratus both of which may change into it. In this case the changing patches often retain some fibrous structure in places.

Real Cirrocumulus is uncommon. It must not be confused with small altocumulus on the edges of altocumulus sheets.

3. CIRROSTRATUS (Cs.).—**A thin whitish veil, which does not blur the outlines of the sun or moon, but gives rise to halos.**

Sometimes it is quite diffuse and merely gives the sky a milky look; sometimes it more or less distinctly shows a fibrous structure with disordered filaments.

NOTE.—The heights given above are for temperate latitudes; they refer not to sea level, but to the general level of the land in the region. In certain cases there may be large departures from the given mean heights, especially as regards cirrus.

* Nimbostratus is grouped with Altostratus in the specifications of cloud forms for daily synoptic reports agreed upon at the Washington Conference 1947.

4. **ALTOCUMULUS** (Ac.).—**A layer (or patches) composed of laminae or rather flattened globular masses, the smallest elements of the regularly arranged layer being fairly small and thin, with or without shading.** These elements are arranged in groups, in lines or waves, following one or two directions and are sometimes so close together that their edges join.

The thin translucent edges of the elements often show **irisations** which are rather characteristic of this class of cloud.

5. **ALTOSTRATUS** (As.).—**Striated or fibrous veil, more or less grey or bluish in colour.** This cloud is like thick cirrostratus but without halo phenomena; the sun or moon shows vaguely, with a faint gleam, as though through ground glass. Sometimes the sheet is thin with forms intermediate with cirrostratus (altostratus translucidus). Sometimes it is very thick and dark (altostratus opacus), sometimes even completely hiding the sun or moon. In this case differences of thickness may cause relatively light patches between very dark parts; but the surface never shows real relief, and the striated or fibrous structure is always seen in places in the body of the cloud.

6. **STRATOCUMULUS** (Sc.).—**A layer (or patches) composed of globular masses or rolls; the smallest of the regularly arranged elements are fairly large; they are soft and grey, with darker parts.** These elements are arranged in groups, in lines, or in waves, aligned in one or in two directions. Very often the rolls are so close that their edges join together; when they cover the whole sky—especially in winter—they have a wavy appearance.

7. **STRATUS** (St.).—**A uniform layer of cloud, resembling fog, but not resting on the ground.** When this very low layer is broken up into irregular shreds it is designated **Fractostratus** (Fs.).

8. **NIMBOSTRATUS** (Ns.).—**A low amorphous and rainy layer of a dark-grey colour and nearly uniform;** feebly illuminated seemingly from inside. When it gives precipitation it is in the form of continuous rain or snow.

But precipitation alone is not a sufficient criterion to distinguish the cloud which should be called nimbostratus even when no rain or snow falls from it. There is often precipitation which does not reach the ground; in this case the base of the cloud is always diffuse and looks "wet" on account of the general trailing precipitation (virga), so that it is not possible to determine the limit of its lower surface.

9. **CUMULUS** (Cu.).—**Thick clouds with vertical development; the upper surface is dome shaped and exhibits rounded protuberances, while the base is nearly horizontal.**

When the cloud is opposite to the sun the surfaces normal to the observer are brighter than the edges of the protuberances. When the light comes from the side the clouds exhibit strong contrasts of light and shade; against the sun, on the other hand, they look dark with a bright edge.

True cumulus is definitely limited above and below; its surface often appears hard and clear cut. But one may also observe a cloud resembling ragged cumulus in which the different parts show constant change. This cloud is designated **Fractocumulus** (Fc.).

10. CUMULONMIBUS (Cb.).—**Heavy masses of cloud, with great vertical development, whose cumuliform summits rise in the form of mountains or towers, the upper parts having a fibrous texture and often spreading out in the shape of an anvil.**

The base resembles nimbostratus and one generally notices **virga.** This base has often a layer of very low ragged clouds below it (fractostratus, fractocumulus).

Cumulonimbus clouds generally produce showers of rain or snow, and sometimes of hail or soft hail and often thunderstorms as well.

If the whole of the cloud cannot be seen, the fall of a real shower is enough to characterize cloud as cumulonimbus.

Specifications for the observations of cloud forms required for synoptic purposes are found in **Manual No. 6 (Weather Code)** and cloud formations are illustrated on the **" Cloud Chart "**, both of which are based on current international practice and are issued separately.

WEATHER PHENOMENA.

The observer should keep an accurate record of all weather phenomena. The majority of those of interest are concerned with the presence of water in the atmosphere in its various forms and for this reason the term " hydrometeors " is used to describe the whole class.

Descriptions of Phenomena.

Rain: Precipitation of drops of water (in the liquid state) in which most drops are larger, or more sparse, than the drops in drizzle.

Drizzle: Consists of rather uniform precipitation exclusively of minute and very numerous water drops, which seem almost to float in the air.

Rain and drizzle may be classified as " intermittent " or " continuous " and as " slight ", " moderate ", or " heavy ".

Snow: Precipitation of water, in the solid state, takes place mainly in the form of branched hexagonal crystals, " stars ", often mixed with simple **Ice Crystals.** At temperatures above $-10°C.$ they generally link together to form flakes.

Snow on the Ground: This should be entered only if at least half the country surrounding the station is snow-covered at the time of the morning observation. The depth of snow should be measured by plunging a rule into it where it is lying evenly over a level surface.

Showers: Are characterized by the suddenness with which they start and stop and by rapid changes in intensity and also by the aspect of the sky—rapid changes between dark threatening clouds (Cb) and clearing of the sky (of short duration, often with an intensely blue sky). Sometimes, however, no definite clearing occurs between the showers, or the precipitation does not entirely cease, but there is usually a more or less rapid alternation of lighter and darker clouds.

Hail: Ice balls, or ice lumps, the diameter of which ranges from 5 to 50 mm. or even more and which fall either detached or fused into greater irregular lumps. They are either transparent or composed of alternating clear and opaque snow-like layers. Hail almost exclusively falls in violent or prolonged thunder-storms. The time of occurrence and damage caused should be noted.

Small Hail: Semi-transparent, round or (occasionally) conical grains of frozen water, about 2 to 5 millimetres in diameter. They generally consist of a grain of soft hail as nucleus with a very thin ice layer around it giving a glazed appearance. They are wet because they usually fall at temperatures above freezing point, often together with rain.

Squalls: The occurrence of a strong wind blowing for a short period. A squall is frequently accompanied by a change of wind direction, a fall in temperature, and a darkening of the sky by clouds

of cumulus or cumulo-nimbus type from which showers may fall. Well marked squalls frequently accompany the passage of a " cold front " over the station.

Notes should be made of the time of the squall, the change of wind direction, and at suitably equipped stations, the maximum wind force, change of temperature, and of pressure.

Gale: A gale is a wind of force 8 (Beaufort scale) or over, and its occurrence should be recorded together with the times of commencement and abatement. Its greatest force should also be noted.

Thunder-storm: Thunder and lightning observed at the station with not more than 10 seconds time interval between their occurrence.

The time of occurrence and direction of motion should be noted and a note should be made of severity or damage caused.

Thunder and Lightning occurring at more than 10 seconds time interval between them should be entered as " Thunder-storm in the neighbourhood." Lightning occurring alone should be entered accordingly.

Fog: Consists of almost microscopically small water drops suspended in the atmosphere, reducing the horizontal range of visibility to less than 1,100 yards. The air usually feels clammy and humid. The fog generally looks whitish except in the vicinity of industrial areas where it may be mixed with smoke or fine dust and thus appear to be of a dirty yellow or grey colour.

Mist: Consists of microscopically small water drops or very hygroscopic particles suspended in the atmosphere. The horizontal range of visibility is greater than 1,100 yards, but is less than 2,200 yards. The water drops are much smaller and more scattered than in fog. The air feels less humid and clammy than in fog and the mist looks more or less greyish.

Duststorm or Sandstorm: has been defined by the Salzburg Congress as dust or sand raised by the wind so that the range of visibility is considerably reduced. An alternative definition* is " any rapidly moving air which contains large amounts of dry opaque particles." This definition excludes " sand devils " or " dust devils " (small whirlwinds carrying sand or dust) and " dust clouds " which are visible as such from the ground but the dust is not in direct contact with the ground.

The most impressive example of dust storm is the " dust wall " which rises from the ground to considerable altitudes and has a well defined outline.

Haze: Dust particles which are dry and so extremely small that they cannot be felt or discovered individually by the eye. However, they diminish visibility and give a characteristic smoky appearance (hazy and opalescent) to the atmosphere. Haze produces a uniform veil over the landscape and subdues its colours. It has a bluish tinge when viewed against a dark background and a dirty yellow or orange tinge against a bright background. It is thus distinguished from the greyish mist, the thickness of which it may sometimes attain.

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* Loewe (after Koschmieder), *Duststorms in Australia,* C.M.B. Bulletin 28.

Dew: Water drops deposited by direct condensation of water vapour from the adjacent clear air, mainly on horizontal surfaces cooled by nocturnal radiation.

Hoar Frost: Thin ice crystals in the shape of scales, needles, feathers, or fans deposited on surfaces cooled by radiation.

Soft Rime: White layers of ice crystals deposited chiefly on vertical surfaces—especially on points and edges of objects—generally in supercooled fog or mist. On the windward side soft rime may grow to very thick layers of a structure similar to that of hoar frost.

Hard Rime: Opaque granular masses of ice deposited in the same manner as soft rime but in " wet air " or " wet fog " at temperatures below 0° C., thus developing a more compact and amorphous structure than soft rime.

Glazed Frost: More or less homogeneous and transparent ice layers which are deposited on horizontal as well as on vertical surfaces from supercooled rain or drizzle.

Unusually Good Visibility: (Pure air) should be entered when the atmosphere has a great clearness and transparency; distant objects and their details stand out in full relief from the background with great hardness and distinctiveness, without any softening veil, at six miles or more.

Mirage: The position and appearance of distant objects are always altered to some extent by the refraction of light which, passing from the object to the observer, has to traverse obliquely layers of air of different density, and sometimes the displacement of position or distortion of appearance is so great as to produce an illusion of apparent water, trees, or buildings. Such phenomena are conspicuous when the variations of temperature close to the ground are very marked, as when in desert countries the ground is strongly heated by the sun.

Halo: (Solar Halo, Lunar Halo). Luminous ring around the sun or moon respectively, at a distance of about 22° (on rare occasions 46°), mostly whitish but sometimes showing the colours of the spectrum. In the latter case the inner edge of the ring is always reddish or brownish, the other colours following in the outer part of the ring but generally being less pronounced. Inside the ring the sky is darker than outside it.

Halos are formed by refraction of the light from the sun or moon in ice crystals of which cirroform clouds are composed.

Corona: (Solar Corona, Lunar Corona). Luminous crown directly surrounding the sun or moon respectively, of a radius seldom exceeding a few degrees, its inner part being bluish, whitish, or yellowish, or showing (faintly) all the colours of the spectrum. The red colours thus always occupy the outer part of the phenomenon. Sometimes there may be observed several repetitions of the spectral colours.

Coronas are formed by the diffraction of the light from the sun or moon, generally by water droplets.

Rainbow: The rainbow is due to refraction and reflection of sunlight (occasionally moonlight) in falling drops of rain. The normal appearance of a bright, well-developed rainbow is as follows:—The chief, or primary, bow shows the sequence of colours—violet, blue, green, yellow, orange and red, the red being on the outside.

A secondary bow is frequently seen of which the radius is 12° greater than that of the primary, while its colours are reversed. There is considerable variation possible in the number of bows, their radii, the number of colour bands, and the colours and their sequences, according to the brilliancy of the illumination and the size of the drops. Rainbows always appear on the sky opposite to the sun or moon.

Owing to the feebleness of the light from the moon it is seldom possible to recognize colour in the **lunar rainbow** which therefore appears as a white or yellowish arch.

Bows formed in fog (**Fog Bows**) also frequently show no colour owing partly to the low illumination and partly to the high proportion of diffused light.

Aurora: The Aurora usually appears as a bright arch beneath which the sky seems to be darker than the surrounding regions. Frequently streamers of light shoot out radially from the arch and sometimes extend beyond the zenith. Occasionally the arch resembles a swaying sheet or curtain and at times several arches can be seen simultaneously.

Observers should note such points as the direction in which the phenomenon appears most intense, the direction of the arches, and their angular heights above the horizon and the length and position of the most prominent streamers. The colour effects visible should also be noted.

The Aurora is an electrical phenomenon and is usually associated with magnetic storms.

Iridescent Clouds: Green or red colours are occasionally seen on the edges of cirrus or cirro–cumulus clouds at a distance from the sun or moon of up to 25° or more. They are also seen at times on the edges of fracto-cumulus or strato-cumulus clouds. The point to note is the angular distance between the sun (or moon) and the patches showing irisation.

Colouration of the Sky: A cloudless sky appears to be blue, but it may show all possible gradations between a deep blue and a whitish-blue shade. It is desirable to note the gradations of colour according to the scheme—deep blue, light blue, pale blue. Such observations give information regarding the purity of the air.

The most beautiful colours are seen at dusk. When the sky is cloudless the colour and form of the first "**purple light**" is worth noting. It is approximately parabolic in shape and appears at a considerable elevation above the point where the sun disappeared. It varies in colour between pink and violet.

The colouring of the western sky and the appearance of the second "**purple light**" after the disappearance of the first are also worth noting, as are "Alpine Glow" and "Afterglow" in places where these occur. These phenomena may be observed in the reverse order at sunrise.

Green Ray: When the sun sets under favorable conditions, the last glimpse of it is coloured a brilliant green. The phenomenon and the corresponding one at sunrise are explained by unequal refraction of light of different colours.

Zodiacal Light is observed as the extremity of an elongated ellipse of soft whitish light, which extends from the sun as centre and appears above the western horizon after sunset (above the eastern horizon before sunrise). The best time to observe it is just after the last traces of twilight have disappeared in the evening (before-morning). It is believed to be due to the reflection of the sun's light from innumerable minute bodies of dust which revolve about the sun. The Light is seen better in tropical than in temperate latitudes.

Crepuscular Rays are due to the illumination of the dust particles in the atmosphere by sunlight. When the sun is low, the shadows of clouds or of mountain peaks will be thrown right across the sky. As the particles in the shadow are much darker than those in the sunlight, the course of such shadows can be traced for varying distances. A series of alternately light and dark bands of irregular formation depending on the configuration of the cloud masses or mountain peaks are thus produced. Crepuscular rays are seen to advantage when appearing just after sunset.

THE MONTHLY RETURN

ENTRIES ON FORM C.M.B. F/68.

The information principally required from Rainfall Observers is the amount of rainfall in the gauge each morning. This is highly valuable for a great variety of purposes. The importance of careful and regular readings will be realized when it is considered that water is one of the most fundamental requirements for the Australian economy and an accurate estimate of Australia's water resources can only be made if reliable rainfall records are available. In addition to regular readings, care should be exercised to see that the records are not spoiled by bad exposure or by interference by animals or by any other agency.

Next to amount of rainfall, the notations of "Phenomena" and of "General Monthly Remarks" (on the back of Form F/68) are of special interest. In order to compile statistics of the frequency of occurrence of the more important meteorological events in a district, it is desired to have complete (but concise) records of such occurrences as thunderstorms, hail storms, dust storms, bush fires, heavy rain storms, floods, frosts, fogs, and so on, with **times of occurrence**, or **duration** and particulars of damage (if any). Cuttings from local newpapers often provide a useful record.

Seasonal notes on the progress of crops and pastures, and on the condition of stock and water supplies, and notes on insect or bird life, the prevalence of pests or diseases in plants, &c., are desired for the compilation of monthly reports on weather and crop conditions.

Unless an observer is specially requested to forward reports by telegraph or otherwise for aviation or forecasting purposes, the remaining columns of the Observations Form may be completed or not, at the option of the observer. If the station is located in a well-exposed situation in open country, accurate estimates of wind direction and speed would be very useful, but if the location is sheltered, such observations may be of doubtful value. These remarks apply also to visibility observations.

Good estimates of " amount of cloud " may prove useful, particularly if a distinction is made between the proportion of sky covered by " low " types of cloud and that covered by " middle " and " high " types. The amount of " low " cloud should be entered as well as the " total amount " of cloud. (See pp. 24-25.)

Rainfall and Evaporation are entered to the date of reading (9 a.m.) and it is understood that the figures in each case represent a total for the preceding 24 hours.

Entries of Amount of Cloud should express the number of eighths of the sky covered. If the sky is clear, " O " should always be entered and not a dash " — ". The latter is generally taken to mean that no observation has been made. If fog or haze obscures the sky, however, the word " fog " or " haze " should be entered in the cloud column. In the case of fog, the figure 8 is also entered (page 24).

WEATHER PHENOMENA.

For statistical purposes it is important that the various phenomena be clearly defined. The following definitions should be observed when making entries in the remarks columns:—

Frosts.—The word " frost " should be entered and not " frosty ". The latter term leaves it uncertain as to whether a frost has actually occurred.

A distinction should be made between a frost at the station and a frost in low-lying parts of the neighbourhood but not at the station.

Fog.—The remark " fog " should be used (not " foggy " or " Fog around station "), but only when the visibility is less than 1,100 yards. If objects are visible at distances of over 1,100 yards the terms " mist " or " haze " may be more appropriate (See definitions page 29).

" River ", " valley " or " sea " fogs should be entered as such, with a qualifying note " distant " if the fog is confined to particular patches and does not otherwise affect the visibility at the station.

Thunderstorm.—The term " thunderstorm " should be reserved for a definite thunderstorm (thunder and lightning with or without rain) passing over the station. If possible, the direction of movement of the storm should be given as well as the time and duration. The words " thunder heard ", " lightning " or " thunderstorm in the neighbourhood " (see page 29), should be used in other cases, giving the direction in which they are seen or heard and time of occurrence.

Dust Storm.—This term is applied to a strong wind carrying thick dust or sand and occurring over a considerable area at the same time. (See also page 29). An exact definition is not clearly established, but the following distinctions should be observed and entered:—

"Dust Storms" (as defined above), "Dust Devils" (or whirlwinds carrying dust or sand), "Dust Clouds" (which are visible at some height above the ground, but are not in contact with the ground) and "Dust Haze" (which is a condition of the atmosphere occurring with light winds). As a guide to the intensity of dust storms or dust haze, the maximum distance at which objects are visible should be given.

Rainfall Entries—Half Points.

Rainfall is entered in points to the nearest whole number. In the case of half points, the nearest odd number is entered, e.g. $8\frac{1}{2}$ and $9\frac{1}{2}$ are both entered as 9. As a special case, half a point is entered as 1 point (and less than half a point as "Trace" (Tr.)).

Date of Entry.—Rain is entered to the date on which the gauge is read and the entry is understood to represent the amount which has fallen in the 24 hours ended 9 a.m. If the gauge is inspected during the day, the water should be left in the gauge and emptied out at 9 a.m. only. An exception is made on rare occasions when there is a danger of the gauge overflowing. See "Method of making a measurement—Heavy Rains." (page 14).

Heavy Downpours.

It is important to record the rate of rainfall during downpours and country observers are asked to note the **duration** of particularly heavy downpours and the amount of rain which falls between the beginning and end of the downpour.

Amounts measured in this manner should be returned to the gauge so that they will be included in the total for the 24 hours.

Days of rain, fog or dew.

A day of rain is defined as a day on which half a point (i.e. one point) or more of rain is recorded.

In the case of precipitation in the form of dew or frost, the amount, if measurable, (i.e. half a point or more) is entered in the rainfall column and is included in monthly and annual aggregates of rain. The word "dew" or "frost" should accompany the entry. Such days are *not counted* as days of rain.

A day of fog is defined as a day on which the visibility at any time is below 1,100 yards.

Changes of Observer, equipment &c.

A note should be made in some convenient space on the Meteorological Observations Form of the date of a change of observer, or of a change in the exposure of the instruments, the date any instrument becomes defective and is adjusted or replaced, or equipment is changed for any other reason (with particulars).

Apparently trivial details of this kind prove very useful for future reference.

SPECIAL NOTES.

Weather and Crops &c.

Notes on the condition of Stock, Crops, Pastures, Water Supply, State of the River (if any), Insect or Bird Life—including the prevalence of pests, the growth and flowering of plants, agricultural activities and pecularities of the season are of value, and space for such remarks is provided on the Meteorological Observations Form.

A summary of such remarks is issued by the Bureau each month for public information.

SUMMARY OF INSTRUCTIONS RE OBSERVATIONS, ENTRIES AND ATTENTION TO INSTRUMENTS.

Rainfall.—Enter in points. Half points counted to the nearest odd number. Be careful to check measurements of heavy rains. Note time and duration of very heavy downpours if convenient and amount recorded within the stated times. See that gauge is level and firmly fixed and not sheltered by shrubs, buildings or trees &c. Be sure the rim is level when replaced after a reading.

Cloud.—Enter in eighths of sky covered. If no cloud, enter " O." If the sky is obscured by fog or haze, enter the word " fog " or " haze " and the figure 8 in the case of fog i.e. 8 (fog) (page 24).

Wind.—Enter direction from which the wind is blowing (i.e. towards which the vane is pointing). If no wind, enter " C " (for " Calm ") under direction and " O " under force.

Weather.—Enter phenomena and times of occurrence as well as descriptive remarks.

Report without delay, breakage and faults which cannot be remedied.

W. M. Houston, Government Printer, Melbourne.